Computer Science

THEORETICAL FOUNDATIONS OF BIODIVERSITY AS A SYSTEM DEFENSE TECHNIQUE

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This project resulted from a literature review and analysis of current papers in system survivability that focus on the possible applications of diversity. The most obvious example of diversity in the real world is in biology, but this connection has led many computer scientists to make misconceptions about diversity and biodiversity. The resulting discussion covers areas of computing where diversity can be applied, properties of and common misconceptions about diverse biological systems, and current attempts to apply diversity to computer security systems. The research ends with new directions for the field to overcome certain problem areas.

One main topic of interest is artificial immune systems, primarily the work done by Hofmeyr and Forrest[1]. Most artificial immune systems are designed with focus on either the classification of self/non-self or the immune network model. However, few computer scientists have properly acknowledged the danger model[2], wherein Matzinger proposes that the most important function of the immune system is identifying when the body is in danger rather than the identification of foreign antigens.

Another point of the research is biodiversity in ecosystem survivability. While the ecology community has identified biodiversity as a property of ecosystems that must be preserved, it is not the only factor that keeps an ecosystem functioning[3]. Furthermore, while many computer scientists note that the loss of biodiversity leads to greater susceptibility to natural disasters and contagion as the basis for their analogies, there has been little effort to study how this diversity originated or how to maintain it. One factor that maintains biodiversity is competition on a local scale[4]. Although there is competition in the software market, the actual running programs on a network do not compete for resources such as memory or clock cycles. Such a situation would be more analogous to a biological ecosystem.

Solutions we have proposed include development of a reliable metric for computing diversity, an increased focus on fundamental laws of biology rather than on specific mechanics, and an avoidance of topics that are not understood at an acceptable level by biologists. We also encourage increased collaboration between biologists and computer scientists to foster these goals.

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[1] Hofmeyr, Steven, and Forrest, Stephanie, "Architecture for an Artificial Immune System," *Evolutionary Computation*, vol. 8, no. 4, pp. 443-473, 2000.
[2] Matzinger, Polly, *The Real Function of the Immune System.* http://cmmg.biosci.wayne.edu/asg/polly.html
[3] Inchausti, Pablo, and Loreau, Michel, *Between Biotics and Abiotics*. http://www.santafe.edu/sfi/publications/Bulletins/bulletin-summer97/works.html
[4] Kerr, Benjamin, and Riley, Margaret A., and Feldman, Marcus W., and Bohannan, Brendan J.M., "Local Dispersal Promotes Biodiversity in Real-Life Game of Rock-Paper-Scissors," *Nature*, vol. 418, pp. 171-174, July 2002.